

advance of temperature at the rate of 10 to 20 miles a day, so that in the central portion planting begins during the first week in April, and in the northern portion about April 20. The planting usually requires two to three weeks to complete, hence is over in the southern districts about April 15 and in the northern districts a month later. When the cotton is a few inches high the rows need to be thinned, which process is known as "chopping out," and is the most laborious task in the cultivation of cotton except that of picking. Chopping out begins in the southern districts of the Cotton Belt usually about the 1st of May, in extreme southern Texas as early as April, and continues for about a month. In the northern districts it begins about June 1 and ends from June 20 to July 5, being usually two weeks later in Arkansas and western Tennessee, especially on the river bottom lands, than at corresponding latitudes in the Carolinas. Cotton picking begins about August 10 in the southern portion of the belt, usually the last week in August in the central portion, and in the northern portion about September 10. The cotton is picked by hand, a slow and laborious process, and three or four pickings are commonly given each field, the first picking of the early maturing bolls and the last picking of the late maturing bolls being much smaller than the midseason pickings. It is usually the first of December before picking is completed in the southern districts and from December 20 to January 1 in the northern districts. Where the acreage is large and the labor insufficient, the picking may drag along into midwinter, though the cotton is by this time likely to be considerably injured by the weather.

#### THE CLIMATE OF SOUTH AFRICA.

By H. E. Woon.

[Extracts from *The South African Geogr. Journ.*, 1918, 2: 5-8.]

\* \* \* In winter the pressure system over South Africa strongly resembles, but is not quite the same as, an anticyclonic system. And as within an anticyclonic region, there is no well-marked wind system, so in winter there are no definite prevailing winds over the Union of South Africa.

As we approach the fringes of the high pressure area the tendency of the wind to have a well-marked prevailing direction increases. Thus, on the northern fringe, at Bulawayo, the wind during the winter months is generally from the east-southeast. At Cape Town, on the southern fringe, there is a certain percentage of winds from the northwest during the winter months. These directions are in accordance with Buys-Ballot's law of the winds according to which, in the Southern Hemisphere if one is standing back to the wind, the higher pressure is on the left hand, the lower on the right.

In general, it may be said that the wind system over the Union in the winter months is such that the surface air tends to move outward. This explains the general absence of rainfall over the Transvaal, the Free State, Natal, and the greater part of Cape Colony during the winter. The air is moving over the surface of dry land, and has no opportunity of becoming laden with moisture. The conditions are rather different over the southwest corner of the Union or the Western Province of Cape Colony. The northwest wind which frequently blows here has traveled for some considerable distance over the South Atlantic Ocean and brings with it some rain to the Cape.

The summer conditions over the Union are of a more complicated character. In the first place, owing to the coming south of the sun the high-pressure belt is pushed south over ocean and land. Further, owing to the greater absorption of solar radiation by the land, the temperature of the land surface becomes higher than that of the ocean on either side. The result is that the high-pressure belt which extends across the land during the winter months now breaks and a large tongue from the equatorial low-pressure belt pushes its way in and lies over South Africa. Thus in the summer months (October-February) the barometer over the interior of South Africa is rather lower than round the coasts, east, west, and south. The barrier of moderately high pressure along the south coast is, however, very weak, and is frequently broken through by cyclones passing off the coast. Now, there is on the whole, an inward draft of surface air from the high-pressure regions over the ocean to the low-pressure system over the land and with the inward drift moisture is brought in to the interior. In not many cases, however, does this fall directly as rain. Occasionally when, owing to a combination of circumstances, there is a strong pressure gradient for northeasterly winds extending over eastern South Africa the moisture is precipitated at once over Natal and the eastern and central Transvaal in a steady rainfall, but generally the precipitation of moisture does not take place directly.

In the great tongue of low pressure over the interior, where the pressure gradient is small and there is very little lateral movement of the surface air, the effect of intense solar radiation is to give rise to local vertical movements of the atmosphere. These are evident in the great cumulus clouds which grow generally during the summer afternoons. \* \* \*

The general direction of motion of the thunderstorms across country is from southwest to northeast.

The summer rainfall over the interior of South Africa may thus be divided into two classes (a) the steady rains, which are associated with northeasterly winds and a fairly steep pressure gradient, and (b) the thunder-showers, which occur with very shallow gradients. The steady rains can be forecast as they follow a well-marked distribution of pressure, but it is a very difficult matter to forecast by even a few hours the occurrence of thunderstorms. Thunderstorm conditions may exist over a huge area of country, but the actual falls of rain are very localized: Johannesburg may have a great downpour of rain whereas Pretoria, a little over 30 miles away, may not receive a drop.

The great frequency of summer thunderstorms over South Africa is due partly to the intense solar radiation and probably also partly to the generally bare character of the country. If the country were more wooded it is quite probable that evaporation would be so modified that the rainfall would be more distributed and lighter in character and the frequency of thunderstorms less. Over the Witwatersrand district 56 per cent of the rainfall is distributed by heavy showers of over one-half inch in amount, whereas at Greenwich, England, only 25 per cent falls similarly in heavy showers.

The region over which rain falls in the winter months is very limited, and is practically confined to the Western Province of the Cape. Such rainfalls are probably associated with cyclonic systems which approach South Africa from the South Atlantic Ocean. Owing to the presence of the high pressure core over the land they can rarely penetrate into the interior and are forced to skirt the

coast. Also as they have traveled over an ocean surface, which is at a rather low temperature, their moisture contents are small, and they lose practically all their moisture when they strike the extreme southwest of Africa. The northeasterly winds which prevail during the summer months have traveled over much warmer water surfaces and, although they deposit the greater amount of their moisture along the Drakenberg Range, which runs parallel to the East Coast, have sufficient left to convey moisture well into the interior. The result of this is that the western half of the Union is, on the whole, much drier than the eastern half. The strip of land along the Natal coast has a rainfall of between 35 and 50 inches per annum, whereas the greater part of the Cape Province, excepting the southwest and south coastal regions, receives only between 5 and 15 inches a year.

Roughly speaking, the mean annual temperature over all parts of the Union is very nearly the same. The higher temperature which would naturally result from an interior situation is almost balanced by the effect due to the greater elevation of the interior. For example, whereas the mean annual temperature at Capetown is 62°, that at Bloemfontein, the altitude of which is 4,400 feet, is 61°.

The variations of temperature are, however, much greater over the interior than at coastal places. Frosts are practically unknown near the coast, but over the interior, owing to the intense radiation from the earth during the dry clear nights they are of frequent occurrence between May and September.

At Capetown, the average shade maximum temperature in January is 78.5°, and the average shade minimum in July is 47.2°, the difference being 31.3°. At an interior town, Kimberley, the average shade maximum in January is 90.5° and the average shade minimum in July is 36.5°, a difference of 54°. The diurnal range of temperature at an interior station as against a coastal station is even more marked than this.

Owing to the fact that the warm Mozambique current flows down the East Coast of South Africa whereas the cold Benguela current flows up the West Coast, the temperatures along the East Coast are higher than those along the West Coast. Durban and Port Nolloth are in very nearly the same latitude, but the mean annual temperature at Durban is 70.8°, that at Port Nolloth 57.5°. It is chiefly due to the influence of this current that the climate of the coastal strip of Natal is rather more tropical than semitropical.

### AUSTRALIAN RAINFALL.<sup>1</sup>

HUNT, H. A., Editor. *Results of rainfall observations made in South Australia and the Northern Territory, including all available annual rainfall totals from 829 stations for all years of record up to 1917.* 421 pp.; maps, diagrams. Bur. of Meteorol., Commonwealth of Australia, Melbourne, 1918. 10s. 6d. 12 x 9½.

The activity of the Australian Commonwealth Bureau of Meteorology is remarkable. A steady stream of important publications continues to flow to the reviewer's desk. Even the war brought no interruption, only delay. The present volume is one of a series, of which three numbers (New South Wales, Victoria, and Queensland) have already been issued, leaving two more still to come (Western Australia and Tasmania). In the issue before us we have tabulations of all the available annual totals of rainfall and of wet days for 829 stations—surely a very large number considering the area concerned—up to the year 1917. For about 200 stations there are also monthly totals to 1915. Such complete information for these sections of Australia has not before been embodied under one cover. Owing to delays due to the war the annual totals for 1916 and 1917 appear in supplementary form. In order to have the work complete for reference and for comparison, authentic annual (for the individual years 1878–1917) and also average annual and monthly rainfall and monthly rainfall maps are included. There are notes on the annual variation and monthly distribution of the rainfall, and a record of notable meteorological events. The incidence of the summer and winter rainfalls and the resultant wheat yields in South Australia are given special attention, the data being presented in both tabular and map form. The monthly and annual meteorological elements and normals for Adelaide and Darwin are given in appendices.

This mere enumeration of the contents of the volume will serve to show how very complete and extensive is the information it contains. There is a remarkable abundance of excellent maps and of diagrams. While the details are of immediate concern only to those who are making special studies of Australian weather and climate, the volume is one which surely deserves mention in the Review. Those who, for one reason or another, have occasion to look up the rainfall conditions of the Australian Commonwealth will realize their lasting indebtedness to Mr. Henry A. Hunt and to his excellent staff of assistants and observers.—*R. DeC. Ward.*

<sup>1</sup> Reprinted from *Geographical Review*, New York, June, 1919, p. 432.

### THE AUSTRALIAN ENVIRONMENT ESPECIALLY AS CONTROLLED BY RAINFALL.<sup>2</sup>

By DR. GRIFFITH TAYLOR,

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[Review—Summary\* by Dr. S. S. Visser, Indiana University.]

This excellent treatise is the third of a series dealing with climatic control of settlement and production in Australia.<sup>3</sup> It is primarily a systematic study of the rainfall of Australia. The rainfall of each of the 15

regions into which the area is divided for the purpose of this study is discussed in some detail. The annual average precipitation for each section is shown in detail by isohyets, lining, and stippling on brown, relief maps (scale 1:5,000,000), compiled by Dr. Taylor.<sup>4</sup> Graphs of the distribution of rainfall throughout the year are given for several stations in each section. Conclusions as to the important sources of rainfall were derived from a study of the daily weather maps for the five-year period

<sup>1</sup> The Australian Environment (especially as controlled by rainfall). A regional study of the topography, drainage, vegetation and settlement; and of the character and origin of the rains. By Griffith Taylor, Physiographer in the Commonwealth Bureau of Meteorology, Commonwealth of Australia. Advisory Council of Science and Industry, Memoir 1, large 4to (10 by 12 in.) 25 by 31 cm., 188 pp., 15 colored contour maps, a Solar Control Model; 111 typical daily weather charts, 15 annual rainfall groups, and 42 other maps and diagrams. Selected bibliography. Government Printer, Melbourne, 1918.

<sup>2</sup> Cf. other reviews: *Scottish Geogr. Mag.*, July, 1919, pp. 250–261; *Nature* (London), Aug. 7, 1919, pp. 447–448; *Quart. Journ. Roy. Meteorological Soc.*, July, 1919, pp. 260–261.

<sup>3</sup> The other two memoirs in the series are "The Control of Settlement by Temperature and Humidity," Bulletin 14 of the Meteorological Bureau, 1918, and "The Climatic Control of Australian Production," Bulletin 11 of the Meteorological Bureau (reviewed in *Geographical Review*, Nov. 1917, pp. 401–403, and Jan. 1918, p. 86). See also "The Settlement of Tropical Australia," *Monthly Weather Review*, 1917, 589–590; and "The Climatic Factors Influencing Settlement in Australia," 14 pp., in *Year Book of the Commonwealth of Australia*, No. 11, 1918.

<sup>4</sup> The maps here published were the basis of the first official orographical map of Australia, recently issued by the department of lands at Sydney.

NOTE.—The prompt publication of the present memoir by the bureau in which it was prepared being prevented by lack of funds, it was published by the Council of Science and Industry.